and to canning and evaporating. The vegetable kingdom is everywhere responsive to the needs of man.

5. *There is a corresponding evolution in the horticulturist.* The rapidity with which education and general intelligence have spread in recent years is patent to every one. The rural classes have risen with the rest, but among the agricultural pursuits horticulture has probably shown the greatest advance in this respect. The horticulturist grows a great variety of products, many of which are perishable, and all of which demand expedition, neatness, and care in marketing. And these many and various crops bring in a multitude of perplexities which not only demand a ready knowledge for their control, but which are important educators in themselves. The horticulturist lives nearer the markets and the villages than the general farmer, as a rule, and he is more in touch with the world. Downing rejoiced in 1852 that there were "at least a dozen societies in different parts of the Union devoted to the improvement of gardening, and to the dissemination of information on the subject." Since that time a dozen national horticultural societies of various kinds have come into prosperous existence, and there are over fifty societies representing States, provinces, or important geographical districts, while the number of minor societies runs into the hundreds. Over fifty States, Territories, and Provinces have established agricultural schools and experiment stations, all supported by popular sentiment. The derision of "book farming" is well nigh forgotten. Subjects which a few years ago were thought to be "theoretical" and irrelevant are now matters of common conversation. In short, a new type of man is coming onto the farms. This uplift in the common understanding of the science of cultivation, and of the methods of crossing and of skilful selection, is exerting a powerful accelerating influence upon the variation of cultivated plants. But the most important and abiding evolution is that of the man himself; and I expect that the rising intellectual status will ultimately lead people to the farm rather than away from it. We are just now living in a time of conspicuous artificialism; but the farm must be tilled and it must be inviting. When agriculture cannot pay, something is wrong with the times.

These, then, are the chief lines of progress in horticulture, and they are all still operative and capable of indefinite growth. The achievement of a generation has been phenomenal. The prospect is inspiring to both the cultivator and the student.

THE IMPORTANCE OF "NEXT-TO-NOTHING" IN CHEMISTRY.

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In the year 1888 the President of the British Association for the Advancement of Science took for the subject of his inaugural address "The Importance of 'Next-to Nothing.'" As a matter of course, Sir Frederick Bramwell treated his subject with his usual wit and ability, and pointed out the influence of small things on the advancement of his particular branch of science—engineering. It might, however, be well to carry the idea still further and to collect together, as far as is possible in a short paper, the facts that have come to light showing the influence of traces of a foreign substance upon chemical change. Some of the facts are almost paradoxical. Take the case of an ordinary coal fire, which was probably one of the first objects which aroused the interest and curiosity of mankind and awakened the instinct of scientific investigation. It is needless to refer to the erroneous views held on the subject of combustion, but it may just be mentioned that the discovery of oxygen seemed to settle the matter and to establish on a firm basis the whole theory of combustion. In the years 1887 and 1888[1] the experiments of Mr. H B. Baker made it quite clear, however, that the presence of aqueous vapor had a great deal more to do with combustion and hence the burning of an ordinary coal fire than we were aware of. He showed that if oxygen be rendered perfectly dry, by leaving it for some time in contact with phosphorus pentoxide, combustion is rendered impossible in such gas. Carbon, sulphur, or phosphorus may be strongly heated in an atmosphere of perfectly dry oxygen without taking fire, and, in fact, the sulphur and phosphorus may be distilled in it. The presence of a trace of moisture at once brings about the combustion. The writer has seen Mr. Baker distil phosphorus in an atmosphere of oxygen and then, whilst the phosphorus was still melted, admit a bubble of oxygen which has been standing over water and at once the phosphorus burst into flame. Hence it is highly probable that the ordinary phenomena of combustion could not take place in our atmosphere if there was not aqueous vapor also present. This would furnish another reason against the probability of the moon's being inhabited, as owing to the absence of aqueous vapor fire would not be possible there.

The great influence of a trace of moisture in bringing about chemical changes in which of itself it is not directly concerned, if we may so express it, is evident from many other observations. Wanklyn discovered that dry chlorine will not combine with dry metallic sodium, but that a trace of moisture will start the reaction. Dixon found that a mixture of carbon monoxide and dry oxygen will not be exploded by the electric spark, but that the presence of a trace of moisture will bring about a silent combination under the influence of the spark, whilst if the gases are moist, the explosion will take place readily.

Again, it has been recently observed that ethylene and oxygen, when perfectly dry, do not explode when acted upon by the electric spark, but the presence of moisture acts in this case as in the former.

Again, carbon dioxide is not absorbed by dry lime. Sulphuretted hydrogen in the dry condition does not tarnish dry silver. Dry iodine does not decompose dry sulphuretted hydrogen.

We may take another example of the influence of next-to-nothing of an impurity in bringing about a change in which its influence had been till lately little regarded. The experiments of Mr. V. H. Veley[2], of Oxford University Museum, on the action of nitric acid on various metals has conclusively shown that the violent action which nitric acid has upon many metals is due to the presence of a trace of nitrous acid in the nitric. He has kept spheres of copper in the strongest nitric acid (freed from the presence of nitrous acid) for some time without any reaction occurring, but when once a trace of nitrous acid or of any nitrite was added, the copper was at once dissolved. The same kind of result was observed when mercury, silver, or bismuth were exchanged for the copper. It was found that from 1 to 2 parts of nitrous acid in 10,000 of the nitric were sufficient to set up the reaction.

Mr. Cross found that jute fibre, when treated with sulphuric acid, is simply hydrolysed. If, however, ordinary nitric acid, containing a trace of nitrous acid, be allowed to act on the jute, a considerable amount of chemical action takes place, and amongst other substances, like urea, which either prevents the formation of nitrous acid or decomposes it as quickly as it is formed, the action of nitric acid on jute is strictly comparable with that of sulphuric acid, simple hydrolysis taking place.

It is highly probable that many of the changes in organic chemistry, generally ascribed to the action of nitric acid alone, are due to the presence of traces of nitrous acid.

It is well known that pure zinc will not dissolve in pure hydrochloric acid or pure sulphuric acid, but the presence of a trace of a metallic salt sets up the reaction very readily.

If we take another branch of chemistry—metallurgical chemistry—the immense importance of the presence or absence of a trace of a foreign substance in a metal is readily seen, since it produces an immediate effect on the hardness or tenacity of the metal, and so may destroy its usefulness in commerce. Take the case of copper. Professor Roberts-Austen states in his Cantor lectures that a cable made of the pure copper of to-day will carry twice as many messages as a similar cable made of the less pure copper of 35 years ago, when the importance of the purity of copper was not so well understood, and he quotes a saying of Sir Wm. Thomson's that the presence of $\frac{1}{10}$ per cent of bismuth in the copper of a cable would entirely destroy its commercial success by reducing its conductivity. Sir Hussey Vivian has

[1] Preceedings of the Royal Society, vol 45, and Phil. Trans., 1889

[2] Philosophical Transactions, 1891.

stated that $\frac{1}{1000}$ part of antimony will convert the best select copper into the worst conceivable. Another instance occurs in the case of iron. By the addition of $\frac{2}{10}$ per cent of carbon steel is produced of such a kind as would make an excellent bridge, or boiler plate, but if fashioned into a weapon would be absolutely untrustworthy. If, on the other hand, $\frac{8}{10}$ per cent of carbon were introduced, a material is obtained from which a good razor might be made, but it would be useless for a rail or the construction of a bridge. A trace of manganese in steel renders it impossible to make a magnet out of such a specimen. It also prevents the hardening of such steel by rapid cooling after heating to redness.

The metal, however, which shows the most remarkable change in its physical properties when contaminated with next-to-nothing of a foreign substance is gold. The addition of $\frac{2}{10}$ per cent of bismuth would render a specimen of gold useless for coinage purposes, as it would crumble to powder under the pressure of the die. Lead acts in a similar way. One part of lead added to two thousand parts of gold reduces its tenacity from 18 tons per square inch to only 5 tons. A bar of such gold can be readily broken by a tap from a hammer. The color of the gold is changed from yellow to orange brown. Such a remarkable change in the appearance and properties of gold on the addition of small quantities of other substances was known in the seventh century and helped to confirm the belief of the alchemists that they had only to find some substance which would alter the properties and appearance of any given metal so that it would change into and acquire the properties of gold. Hence the search for the philosopher's stone.

This paper might be indefinitely extended, but enough has probably been said to show that even in chemistry the day of small things is not to be despised, and that a thorough investigation of some of the commonest and best-known chemical changes would doubtless bring to light many facts at present overlooked, and would tend to a better understanding of the workings of nature.

BREAD-FRUIT TREES IN NORTH AMERICA.

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THE living species of the genus Artocarpus are exclusively Old World, being confined in their distribution to tropical Asia and the Malay Archipelago. About forty species have been described, of which number two or three are now widely cultivated throughout the tropics, the most important of these being *A. incisa*, the true bread-fruit tree. They are small or medium-sized trees with a milky juice, and large, leathery, entire, or pinnately lobed, or rarely pinnately compound leaves. The flowers are monœcious with the staminate ones borne in long club-shaped spikes, and the pistillate in rounded heads. The female flowers soon grow together and form one large, fleshy mass, or the so-called bread-fruit. When mature, the fruit is marked on the exterior with hexagonal knobs, and in the interior consists of a whitish pulp, having the consistence of new bread, whence its name.

Although not at present an element in the flora of the New World, there is now abundant evidence to show that the genus Artocarpus was, during late Cretaceous and earlier Tertiary times, an inhabitant of North America. The best known species, called *Artocarpus lessigiana* (Lx.), was discovered in 1874 in the Lower Laramie on Coal Creek, in Boulder County, Colorado. It was first described by the late Professor Leo Lesquereux, under the name of *Myrica ? lessigiana*, on the supposition that it was a gigantic representative of the genus Myrica. Specimens, now known to represent the upper portions of large leaves, were later obtained from the andisitic deposits forming the recently differentiated Denver formation of South Table Mountain, near Golden, Colorado. These leaves were called *Aralia pungens* by Professor Lesquereux, who naturally confounded the imperfect examples at his disposal with well known fossil forms of this genus, which they much resemble. Since that time several additional specimens have been obtained, which not only prove that *Myrica ? lessigiana* and *Aralia pungens* are identical, but also that they should be referred to Artocarpus.

The leaves of *Artocarpus lessigiana* were very large, measuring 30 centimeters in length and 18 or 20 centimeters in width. They are thick, probably coriacious in texture, broadly oblong in general outline, and deeply, pinnately 4–6-lobed. The lobes are oblong, lanceolate, taper-pointed, and separated at the base by broad, rounded sinuses, the lobation being most extensive at the base of the leaf, where the sinus almost reaches the midrib, and the two lower lobes are connected by a narrow ring only. The nervation of the leaf is very strong, and precisely like that of the living *A. incisa*, which differs from the fossil in having the deepest lobation in the upper part of the leaf.

Closely allied to this species, and possibly identical with it, is what I propose to call *Artocarpus californica*, which is founded upon specimens obtained by Dr. Cooper Curtice, then of the U. S. Geological Survey, from the auriferous gravels at Independence Hill, Placer County, California. This species differs from the former by its smaller size, thinner texture, and shorter, more acute, lobes. It is not sufficiently well preserved to show the finer nervation, but, as far as can be made out, it is very similar to *A. lessigiana*, and additional material may show them to be the same.

Specimens, probably belonging to this species (*A. californica*), were obtained some years ago from the John Day Valley in Oregon, the age of which is either Upper Miocene or Lower Pliocene. They were identified by Professor Lesquereux both with his *Myrica ? lessigiana* and *Aralia pungens*; but, as they are somewhat fragmentary, it is not possible to be positive as to their correct determination.

The most northern point at which the genus Artocarpus has been found fossil is northern Greenland, in latitude 70°. Dr. A. S. Nathorst obtained a large leaf, which he named *A. dicksoni*, in the Cenomanian near Waigatt. This species is also closely related to *A. incisa*, and was associated with a fruit which is unquestionably that of a bread-fruit tree. Nathorst, who was the first to point out the true relationship of Lesquereux's *Myrica ? lessigiana* and *Aralia pungens*, suggests the possibility of their being the descendants of the Greenland species, which may have deen dispersed over the North American continent by the ice-sheet. The material at present available is hardly sufficient to establish unquestioned relationship between them, for the nervation of *A. dicksoni* is not to be made out, but, as all are undoubtedly related to the living bread-fruit (*A. incisa*), they may be more closely related among themselves than now seems apparent.

From the above account, it appears that the bread-fruit trees existed in North America as far north (in Oregon) as 46°, and as late as early Pliocene or late Miocene time. The reason for their complete disappearance from the American flora, and that within such a comparatively short space of time, is difficult to supply. If they had been pushed southward, and now inhabited the tropics, it would be readily explainable, and quite in accord with other well-known instances, but they have totally disappeared from the New World, notwithstanding the fact that they grow when transplanted as freely in tropical America as in their native country. It is probable that the advance of the refrigeration was so rapid that they were unable to escape in the New World, and perished to the last one, while in the Old World some avenue permitted their perpetuation. The genus Eucalyptus is another example of the same condition. During Cretaceous and Tertiary times it was an inhabitant of North America and Greenland, but is now entirely confined to Australia.

The deductions to be drawn, as to the climate that prevailed at the time when these trees existed in North America, are to be made with caution. The fact that all the living species of a genus are tropical does not necessarily prove that it has always been so. Again, a genus that is essentially tropical may have species extending into sub-tropical or even temperate regions. The genus Dicksonia is a marked example of this kind. It is principally an inhabitant of tropical America and Polynesia, but one species reaches as far north as Canada, and several are scattered throughout the southern part of the temperate zone.

Taken by itself, Artocarpus would indicate a tropical climate, but the plants with which it is associated have also great weight